Time: 3 Hours **Total Marks: 80**

Note: 1) Question No.1 is **Compulsory**
2) Attempt any three questions out of the remaining five questions.
3) Figures to the right indicate full marks.
4) Assume suitable data wherever required.

Q1 Attempt any four **(20)**

A. Explain the impact of automation on productivity and cost in manufacturing systems.
B. What is the difference between uninformed and informed search algorithms? Explain with examples.
C. What are the basic components of an Artificial Neural Network? List and explain briefly.
D. Define a point-to-point control system used in the robotic system with suitable applications.
E. What is latching in PLC programming? Draw a ladder diagram to demonstrate latching using a push button.

Q2 A Design simple pneumatic circuit for two-cylinder operation with the following sequence using 4/2 pilot-operated valve as DCV using cascade method **(10)**
Delay B+ A+ A- B-, With user option of single cycle – multi cycle. Also draw displacement diagram.

B Compare supervised learning with unsupervised learning. Discuss their major differences in data labelling, model training, and algorithm use. **(10)**

Q3 A What is meant by agent and explain its types with reference to Artificial Intelligence. **(10)**
(include sketches)

B Illustrate with neat sketches mechanical and magnetic type of end effectors used in robotic system, stating its advantages and disadvantages. **(10)**

Q4 A Compare BFS and DFS based on the following parameters: **(10)**
i) Approach (Strategy), ii) Data structure used, iii) Time complexity, iv) Space complexity,
v) Completeness and optimality

B Illustrate with neat sketch hydraulic intensifier circuits. **(10)**

Q5 A Design electro-pneumatic circuit for two-cylinder operation with the following sequence using 5/2 both side solenoid-operated valve as DCV. **(10)**
A+B+Delay B- A- , With user selection option single cycle Multicycle operation.

B How do pitch, yaw, and roll relate to the degrees of freedom in a robot? Explain with examples. **(05)**

C Illustrate with neat sketches, the logic of AND and OR gates, used in operation of pneumatic circuits. **(05)**

Q6 A Define Natural Language Processing (NLP). Explain its role and applications in industrial automation. **(10)**

B Differentiate between PLC and Relays. **(05)**

C Illustrate K nearest neighbours algorithm used in machine learning. **(05)**

Time: 3Hrs **Marks:80**

NB:

1. **Question No.1** is compulsory
2. Attempt **any three questions from the remaining questions**.
3. **All questions carry equal marks.**
4. **Assume suitable data** if necessary and **state it clearly**.
5. **Use of Refrigerant tables, Friction Charts, Psychrometric Charts, and Steam Tables are permitted.**

1 **Answer any four from the following** **20**

a. Explain the classification of refrigerants with an example. **5**

b. A machine working on a Carnot cycle operates between 305 K and 260 K. Determine the C.O.P. when it is operated as: 1. A refrigerating machine; 2. A Heat Pump, and 3. a heat engine. **5**

c. Write a note on a Heat Pump. **5**

d. Define the term 'effective temperature' and explain its significance in the design of air conditioning systems. **5**

e. State the types of Expansion device and explain the working of any one with neat diagram. **5**

f. State the various applications of HVACR and explain any one application. **5**

2 **a.** Draw a neat diagram of a three-fluid system of refrigeration (Electrolux refrigeration system) and explain its working. **08**

b. A Simple evaporative air refrigeration system is used for an aeroplane to take 20 tonnes of refrigeration load. The ambient air conditions are 20°C and 0.9 bar. The ambient air is rammed isentropically to a pressure of 1 bar. The air leaving the main compressor at pressure 3.5 bar is first cooled in the heat exchanger having effectiveness of 0. 6 and then in the evaporator where its temperature is reduced by 5°C. The air from the evaporator is passed through the cooling turbine, and then it is supplied to the cabin, which is to be maintained at a temperature of 25°C and at a pressure of 1.05 bar. If the internal efficiency of the compressor is 80% and that of cooling turbine is 75%, determine: 1. Mass of air bled off the main compressor; 2. Power required for the refrigerating system, and 3. C.O.P. of the refrigerating system. **12**

3 **a.** A vapour compression refrigerator uses R-12 as refrigerant and the liquid evaporates in the evaporator at - l5°C. The temperature of this refrigerant at the delivery from the compressor is 15°C when the vapour is condensed at 10°C. Find the coefficient performance if (i) there is no undercooling, and (ii) the liquid is cooled by 5°C before expansion by throttling. **10**

Take specific heat at constant pressure for the superheated vapour as 0.64 kJ/kg K, and that for liquid as 0.94 kJ/kg K. The other properties of refrigerant are as follows:

Temperature in °C	**Enthalpy in kJ/ kg**		**Specific entropy in kJ/kg K**	
	Liquid	Vapour	Liquid	Vapour
-15	22.3	180.33	0.0904	0.7051
10	45.4	191.76	0.1750	0.6921

b. A vapor compression cycle using refrigerant R-22 operates at a condensing temperature of 34°C and an evaporative temperature of -10°C. For a mass flow rate of the refrigerant equal to 0.33 kg/s. **Determine the following: Use p-h chart**: 1. The compressor power; 2. The refrigerating effect; 3. The coefficient of performance. **10**

4 a. Explain various psychrometric processes. **08**

b. The following data refer to air conditioning of a public hall: **12**
Outdoor conditions = 40°C DBT, 20°C WBT
Required comfort conditions = 20°C, DBT, 50% RH
Seating capacity of hall = 1000
Amount of outdoor air supplied = 0.3 m^3/min/person
If the required condition is achieved first by adiabatic humidifying and then cooling, find:
1. The capacity of the cooling coil and surface temperature of the coil if the by-pass factor is 0.25, and 2. The capacity of the humidifier and its efficiency

5 a .800 m^3/min of recirculated air at 22^0C DBT and 10^0C dew point temperature is to be mixed with 300 m^3/min of fresh air at 30^0C DBT and 50% RH. Determine the enthalpy, specific volume, humidity ratio, and dew point temperature of the mixture. Determine: **10**
a. Enthalpy
b. Humidity Ratio
c. Specific volume and
d. DPT of the mixture

b Draw a neat sketch of Air Handling Unit showing each component. Also, state the functions of each component. **10**

6 a A duct of 15m length passes air at the rate of 90 m^3/min. Assuming the friction factor as 0.005, calculate the pressure drop in the duct in mm of water when (a) the duct is circular of diameter 0.3 m; and (b) the duct is of 0.3 m square cross-section. **10**

b **Answer Any TWO.** **10**

1. Define human comfort. Explain the factors affecting human comfort. **5**

2. Define: i) Ton of Refrigeration ii) Bypass Factor iii) Dry bulb temperature iv) Wet bulb temperature v) Humidity ratio **5**

3. Dairy and food processing plant **5**

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[03 Hours] **[Total marks – 80]**

N.B.:
1. Question No **1** is **compulsory**
2. Solve **Any Three** questions from the remaining **Five** questions.
3. Assume any **suitable data** if necessary with justification.
4. Use of **Standard Data Book** is permitted
5. Figures to the right indicate full marks.

Q1. Attempt any **Four** of the following. **20**

(a) Explain self-locking and Overhauling Screws? **05**

(b) List out the design considerations in casting & Forging **05**

(c) Explain Nipping of leaf spring **05**

(d) Differentiate between hydrostatic bearing and hydrodynamic bearing? **05**

(e) Define stress concentration and with neat sketches explain various methods to reduce the effect of stress concentration. **05**

Q2. **(a)** Design a Socket and Spigot Cotter Joint for an axial load of 20 kN by selecting suitable material. Check Cotter for bending and draw the neat sketch of joint. **15**

(b) Explain surge in spring with the methods to eliminate it. **05**

Q3. **(a)** Determine the suitable diameter for the solid shaft, if it is supported by two bearings placed 800 mm apart. A 300 mm diameter pulley is mounted at a distance of 250 mm to the right of left hand bearing and this drives a pulley directly below it with the belt. Another pulley 400 mm diameter is placed 350 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulley is 180° & $\mu = 0.3$. The shaft transmits 12 KW at 1440 rpm and weight of pulley A is 300 N and that of B is 450 N. Assume that the torque of one pulley is equal to that of the other pulley. **15**

(b) A piston rod of hydraulic cylinder exerts an operating force of 10kN. The friction due to piston packing and stuffing box is equivalent to 10 % of operating force. The pressure in the cylinder is 10 MPa. The cylinder is made of Cast Iron, FG 200 and Factor of safety is 5. Determine the diameter and thickness of cylinder. **05**

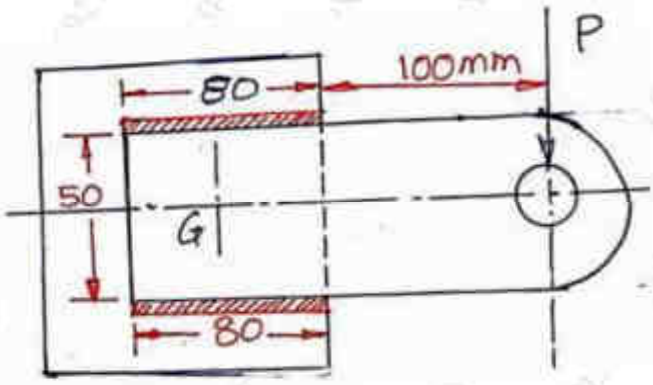
Q4. **(a)** DGBB is subjected to a radial load of 5 KN and axial load of 2.5 KN when operating on 600 rpm. Consider the expected life of 20000 hours with survival probability of 93%. Select suitable standard bearing from the manufacturer's catalogue. **10**

(b) A radial load on 360^0 hydro dynamically lubricated self-contained bearing supports 10kN. The journal rotates at 1450 rpm. Assuming journal length to it diameter as 1 with the bearing length as 50 mm. Take radial clearance as 20 microns, eccentricity as 20 microns, specific gravity of lubricants as 0.86, specific heat of lubricants 2.09 kJ/kg ^{0}C. Find, **10**

i. Oil film thickness.
ii. Coefficient of friction.
iii. Viscosity

Q5. **(a)** A protected type flange coupling is required to transmit 20 kW at 900 r.p.m. Design the coupling by selecting suitable materials for various component. **10**

(b) A plate welded to a channel as shown in fig. no.1, is subjected to an eccentric load P= 8 KN. Determine the size of weld if the permissible shear stress for the weld is not to exceed 80 MPa. **10**



(Fig. No.1)

Q6. **(a)** A single cylinder four stroke cycle internal combustion engine produces 15 KW power at 700 rpm. Design a suitable flywheel, assuming coefficient of fluctuation of speed as 0.04. The torque developed during the power stroke may be considered as sine curve and work done during the power stroke is 30% more than the work done per cycle. **12**

(b) Determine the size of rubber canvas belt to transmit 5 kW from an electric motor rotating at 960 rpm to an intermediate shaft of a machine tool. The approximate reduction ratio is 2.8 and expected life is 1200 hours. Also check for induced stress in the belt. **08**

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Time:3 Hours **Marks: 80**

Instructions:

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining FIVE** questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.
- Use of steam table is permitted.

			Marks
Q. 1		Solve **ANY FOUR** questions from following. (Each question carries 5 marks)	**(20)**
	a)	Describe construction and working of Economiser with neat sketch.	
	b)	Write short note on compounding of Impulse turbine.	
	c)	Explain the construction and working of double acting reciprocating pump with neat sketch.	
	d)	Illustrate impulse momentum principle and reaction principle in Hydraulic turbines.	
	e)	What is surging and chocking in compressor.	
Q. 2	**a)**	A Pelton wheel is to designed for the following specification: Power (Brake or Shaft) = 9560 kW, Head = 350 m, Speed = 800 RPM, Overall efficiency = 85%, Jet Diameter is limited to $1/6^{th}$ of the wheel diameter. Determine the wheel diameter, diameter of jet and number of jet required. Take C_v=0.985 and speed ratio = 0.45.	**(10)**
	b)	Illustrate working of La-Mont boiler and Once through boiler with the help of neat sketch.	**(10)**
Q. 3	**a)**	In a gas turbine plant , the air enters a compressor from ambient at a pressure of 1 bar and 10°C. The static pressure at the suction of the compressor is 0.9 bar and compresses it to total pressure of 6.0 bar and a total temperature of 230°C. The air expands in the turbine upto a total pressure of 1 bar and total temperature of 460°C. The net output of the turbine is 1930 kW. Calculate: i) Total head isentropic efficiency of the compressor. ii) Velocity at entrance to the compressor iii) Mass flow rate if the area at entry to the compressor is 0.1 m^2. iv) The temperature of gases at the entry to the turbine. Neglect all other losses and the mass of fuel. Assume C_{pa} = 1.05 kJ/kg K for compressor, C_{pg} = 1.13 kJ/kg K for turbine, γ =1.4 throught and R=300 Nm/kg K for air.	**(10)**
	b)	State and derive the expression for equivalent evaporation of boiler and boiler efficiency?	**(10)**

Q. 4 **a)** The following data is recorded during a trial on a boiler: **(10)**
Duration of trial=8 hrs., Pressure of steam leaving the boiler = 14 bar, Condition of steam leaving the boiler = 0.973 dry, Feed water evaporated = 26700 kg, Temperature of feed water at inlet = 50 °C, Mass of coal fired = 4260 kg, Calorific value of coal fired = 28900 kJ/kg, Air supplied per kg of coal fired = 17 kg, Temperature of flue gas leaving boiler = 344 °C, Boiler house temperature = 21 °C, Specific heat of flue gases at constant pressure = 1.1 kJ/kg K. Determine i) Boiler efficiency ii) Equivalent evaporation iii) Heat lost to flue gases.

b) Draw a general layout of a hydroelectric power plant using a Pelton turbine and define the following: (a) Gross head, (b) Net head, (c) Mechanical efficiency (d) Overall efficiency of the Pelton turbine. **(05)**

c) Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes. **(05)**

Q. 5 **a)** A centrifugal pump having outer diameters equal to two times the inner diameters and running at 1000 rpm works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm. Determine: **(10)**
(i) Inlet vane angle,
(ii) Work done by the impeller on water per second, and
(iii) Manometric efficiency

b) What is Euler's theory? What is the use of it in pump and turbine **(05)**

c) Illustrate working of Turboprop Engine. **(05)**

Q. 6 **a)** A reaction turbine works at 450 rpm under a head of 120 m. Its diameter at inlet is 1.2 m and the flow area is 0.4 m^2. The angles made by absolute and relative velocities at inlet are 20° and 60° respectively with the tangential velocity. Determine the volume flow rate and the power developed by the turbine. **(10)**

b) Derive an expression for condition to get maximum efficiency in De-laval turbine. **(10)**

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